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(54) Disc-shaped recording media and recording/reproducing apparatus therefor.

(57) A disc-shaped recording medium (1) has a diameter of not more the 80 mm and a recording track pitch of approximately 1.6 μm. In excess of 130 Mbytes of information is recorded in a data compressed state on the medium (1), which is rotationally driven at a constant linear velocity for recording and optically reproducing the information. A recording/reproducing apparatus for the medium (1) includes a buffer memory (23) between a data compressing circuit (23) for compressing input digital data and a recording encoding circuit (26, 27) for processing the compressed data by modulation suitable for recording, and a buffer memory (25) between a playback decoding circuit (33, 26) and a data expansion circuit (23) for expanding the compressed data to the original state. The capacity of the buffer memories (25) is selected such that recording and reproduction may continue satisfactorily even if there is a track jump during recording or reproduction.

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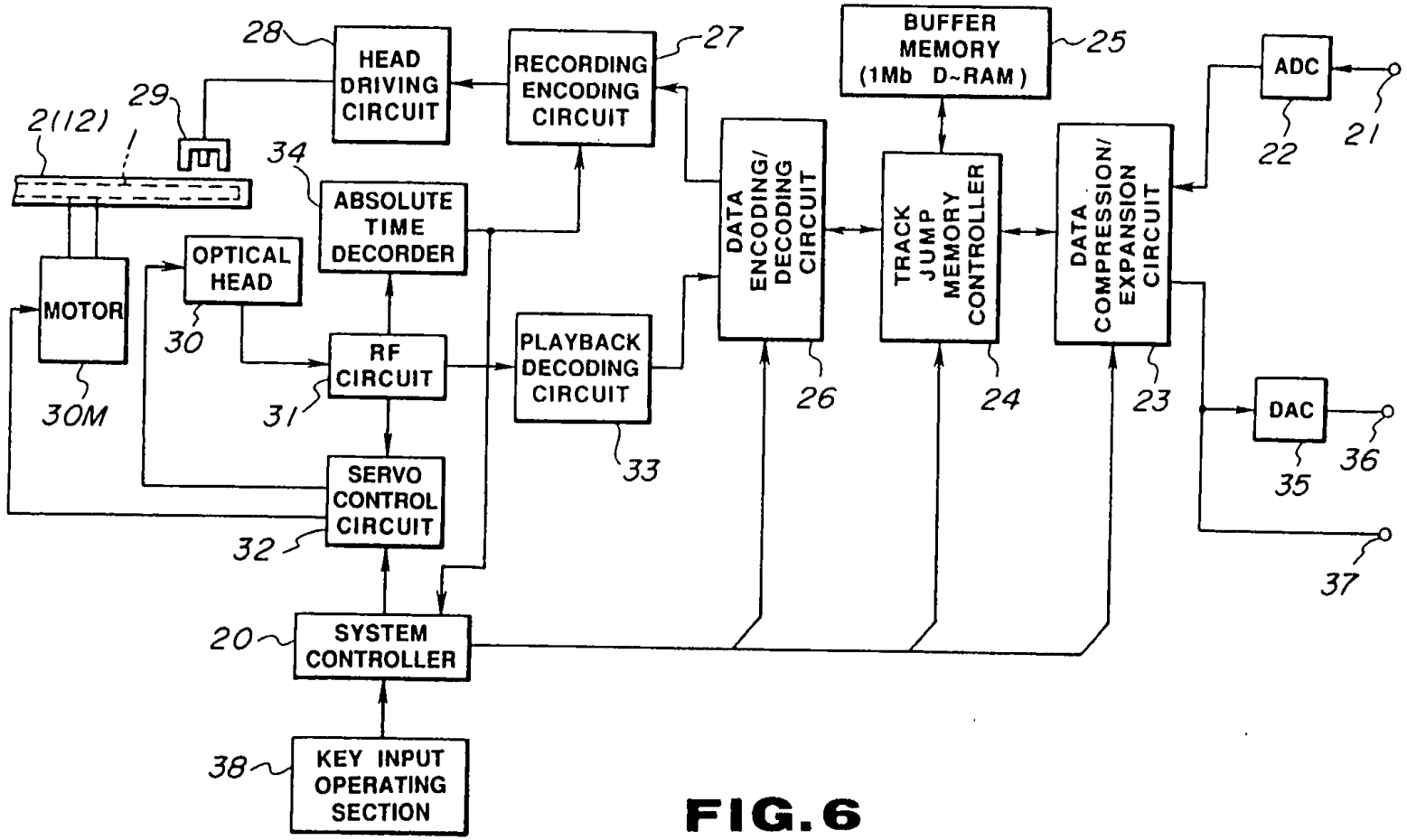
28
HEAD DRIVING CIRCUIT
RECORDING ENCODING CIRCUIT
27
BUFFER MEMORY (1Mb D-RAM)
25
ADC
22
21
29
2(12)
34
ABSOLUTE TIME DECORDER
DATA ENCODING/ DECODING CIRCUIT
TRACK JUMP MEMORY CONTROLLER
DATA COMPRESSION/ EXPANSION CIRCUIT
OPTICAL HEAD
30
MOTOR
30M
RF CIRCUIT
31
PLAYBACK DECODING CIRCUIT
33
26
24
23
DAC
35
36
SERVO CONTROL CIRCUIT
32
37
20
SYSTEM CONTROLLER
38
KEY INPUT OPERATING SECTION

FIG. 6

This invention relates to disc-shaped recording media, and to recording apparatus, reproducing apparatus, and recording and/or reproducing apparatus therefor.

Current optical discs form disc-shaped recording media which may be classified into three types; a reproduce-only type, a once-write type and an over-write type, and have a variety of disc diameters and recording capacities.

A feature of an optical disc is that it is small in size and yet is capable of recording and/or reproducing a large amount of information.

For example, in the case of a compact disc (CD) as used for audio signals, a recording track comprising a train of pits is formed spirally at a track pitch of 1.6 μm in a 50 to 116 mm diameter region of a disc which is 120 mm in diameter, and 60 minutes of 2-channel audio signals may be recorded.

A CD is rotated at a constant linear velocity of 1.2 to 1.4 m/s and the recording track formed thereon is scanned by an optical pick-up for detecting by light diffraction the presence of absence of the pits for reproducing the recorded signals. During reproduction, in order for the optical pick-up to scan the recording track correctly, tracking servo control is performed, in addition to focusing servo control.

Recently, an optical disc with a diameter of 80 mm has been proposed, which, while having recording specifications and a signal format similar to those of a CD, has a playback time shorter than that of a CD, so the data capacity is smaller than that of a CD.

Car-mounted and portable reproducing apparatus for CDs take advantage of the small size thereof. With this type of reproducing apparatus, means must be provided for combatting the effect of vibration which would produce track jump. Should track jump occur, the tracking servo control as well as the focusing servo control is lost, which interrupts playback signals or produces unnatural playback signals. The usual practice has been to provide a mechanically strong vibration-proofing system.

The size of a reproducing apparatus is determined partly by the disc diameter. Since a CD has a diameter of 120 mm, the reproducing apparatus cannot be reduced in size beyond a certain limit value, meaning that the apparatus is slightly too large conveniently to be used as a portable apparatus. In addition, with a portable type apparatus, the vibration-proofing inevitably leads to an increased size.

Although reduced data capacity or playback time would reduce the disc size and hence the size of the reproducing apparatus, this would reduce the utility of the apparatus.

According to the present invention there is provided a disc-shaped recording medium comprising a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Mbytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity.

According to the present invention there is also provided a recording apparatus for a disc-shaped recording medium, the apparatus comprising a rotational driving means for rotationally driving the medium which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Mbytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising:

data compression means for data-compressing input digital information; recording encoding means for processing compressed data from said data compression means by error correction encoding and predetermined modulation;

recording means for recording encoded data from said recording encoding means on said medium; and

a buffer memory associated with said data compression means and said recording encoding means, said buffer memory having at least a data capacity capable of storing data from said data compression means corresponding to a recording time between an occurrence of a track jump and resetting to a correct track position.

According to the present invention there is also provided a reproducing apparatus for a disc-shaped recording medium, the apparatus comprising rotational driving means for rotationally driving the medium which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Mbytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising: an optical head for reading compressed data from said medium; an RF circuit for detecting playback signals from an output of said optical head;

playback decoding means for processing said playback signals from said RF circuit by error correc-

tion decoding and by demodulation complementary to modulation performed during recording;

data expansion means for expanding compressed data from said playback decoding means; and

a buffer memory associated with said playback decoding means and said data expansion means, said buffer memory having a capacity at least sufficient to supply data to said data expansion means corresponding to a playback time between occurrence of a track jump and resetting of said playback position to a correct track position.

According to the present invention there is also provided a recording and/or reproducing apparatus for a disc-shaped recording medium, the apparatus comprising rotational driving means for rotationally driving the medium which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 bytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising:

data compression means for data-compressing input digital information; recording encoding means for processing compressed data from said data compression means by error correction encoding and predetermined modulation;

recording means for recording encoded data from said recording encoding means on said medium;

an optical head and means for generating an external magnetic field provided facing each other with said medium in-between; an RF circuit for detecting playback signals from an output of said optical head;

playback decoding means for processing said playback signals from said RF circuit by error correction decoding and by demodulation complementary to modulation performed during recording;

data expansion means for expanding the compressed data from said playback decoding means; and

a buffer memory associated with said playback decoding means and said data expansion means, said buffer memory having a capacity at least sufficient to supply data to said data expansion means corresponding to a playback time between the occurrence of a track jump and resetting of said playback position to a correct track position.

An embodiment of the invention may provide a disc-shaped recording medium having a diameter not larger than 80 mm, wherein a recording track is formed at a track pitch of approximately 1.6 μm, not less than 130 M bytes of information is recorded on said recording track in a data compressed state, and recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity.

A recording apparatus employing the disc-shaped recording medium as a recording medium may comprise a disc driving unit for rotationally driving the recording medium at a constant linear velocity, data compression means for data-compressing input digital information, a recording encoding circuit for processing compressed data from the data compression means by error correction encoding and predetermined modulation suited for recording, a magnetic head for recording encoded data on the disc-shaped recording medium, and a buffer memory between the data compression circuit and the recording encoding circuit, said buffer memory having a data capacity at least capable of storing data from the data compression circuit corresponding to a recording time between an occurrence of a track jump and resetting to a correct track position.

A reproducing apparatus for optically reproducing information from the disc-shaped recording medium may comprise a disc driving unit for rotationally driving the disc-shaped recording medium at a constant linear velocity, an optical head for reading compressed data from the disc-shaped recording medium, an RF circuit for detecting playback signals from an output of the optical head, a playback decoding circuit for processing the playback signals from the RF circuit by error correction decoding and by demodulation complementary to modulation performed during recording, and a buffer memory between the playback decoding circuit and the data expansion circuit, said buffer memory having a capacity at least sufficient to supply data to the data expansion circuit corresponding to a playback time between the occurrence of a track jump and resetting of the playback position to a correct track position.

Although the disc-shaped recording medium is of an extremely small diameter of not more than 80 mm, data are recorded with data compression, such that 130 bytes or more of information, for example, audio signals continuing for a time longer than 60 minutes, more specifically, for 74 minutes, may be recorded or reproduced.

With the recording apparatus, digital data may be recorded on a disc-shaped recording medium having a diameter of not more than 80 mm with data compression and with error correction code data annexed to the digital data. If a track jump should occur during recording, data read-out from the buffer memory is discontinued to perform only data read-out from the data compression circuit, and data read-out from the buffer memory is restarted after the recording position has been reset to s correct position, thereby assuring continuous data recording.

If a track jump should occur during reproduction, data recording into the buffer memory is discontinued and only data readout is performed. Data writing is restarted after correction of the reproducing position, so that reproduction may be continued without interruption of playback signals.

The invention will now be described by way of example with reference to the accompanying drawings, throughout which like parts are referred to by like references, and in which:

Figure 1A is a plan view of a disc-shaped recording medium according to the present invention;

Figure 1B is a side elevational view of the recording medium of Figure 1A;

Figure 2 is a plan view showing a disc cartridge having accommodated therein a reproduce-only optical disc;

Figure 3 is a bottom view of the cartridge of Figure 2;

Figure 4 is a plan view showing a disc cartridge having accommodated therein a magneto-optical disc for recording and reproduction;

Figure 5 is a bottom view of the cartridge of Figure 4;

Figure 6 is a block circuit diagram showing a disc recording and/or reproducing apparatus according to the present invention; and

Figure 7 is a timing chart.

Referring to Figure 1A, a disc-shaped recording apparatus (disc) has an outer diameter D of 64 mm, a centre hole diameter d of 10 mm and a signal recording area W, shown by hatching, of diameter 32 mm and more. The disc 1 has a thickness t which, as shown in Figure 1B, is equal to 1. 2 mm.

A recording track is formed spirally on the disc 1 at a track pitch of 1.6 μm. The disc 1 is driven rotationally at a constant linear velocity of 1.2 to 1.4 m/s.

In the present embodiment, 130 M bytes or more of information may be recorded by compression of the information for recording.

For example, when audio signals undergo analogue to digital conversion at a sampling frequency of say 44.1 kHz on a 16-bit-per-sample basis, 2-channel audio data of 60 minutes or longer may be recorded and/or reproduced by compressing the digital audio data to, for example, 1/4.

For the present embodiment, two different disc types may be contemplated. The first type is a reproduce-only optical disc, on which signals are recorded by a train of pits produced by injection moulding or the like, and the second type is an overwrite type magneto-optical disc having a photomagnetic recording layer for recording, reproduction and erasure.

The reproduce-only optical disc includes a transparent disc base plate of polycarbonate or PMMA, on which information signals, herein digital audio signals in the form of a train of pits, have been transferred by injection moulding from a pattern of projections and valleys of a stamper consistent with the information signals. A reflecting film of a metal, such as aluminium, is deposited on the surface of the recording layer, such as by vacuum deposition or sputtering, and a protective layer of an UV resin or the like is applied on the reflective layer, such as by spin coating.

The over-writable magneto-optical disc includes a disc base plate of a transparent plastics material, such as polycarbonate or PMMA, on which a photomagnetic recording film (perpendicular magnetization film) of, for example, TbFeCo, is deposited, such as by vacuum deposition or sputtering, and a protective film of, for example, UV resin, is deposited thereon.

It is noted that, in the case of a magneto-optical disc, recording conditions may be prerecorded by a train of pits formed as prepits or prepatterns in a 30 to 32 mm diameter region of the disc, as shown by a broken line in Figure 1A, simultaneously with moulding of the disc base plate such as by injection moulding.

There is also formed on the disc 1 a pregroove for tracking control, that is a pregroove for controlling a light spot irradiated from an optical head on the disc. An absolute time code may be recorded in the pregroove in superimposition on the wobbling signals used for tracking.

In the present embodiment, the disc 1 is accommodated in a disc cartridge 2 shown in Figures 2 and 3 to prevent damage to or deposition of dust and dirt on the disc 1.

The cartridge 2 accommodates a reproduce-only optical disc 1 and comprises an upper half and a lower half of synthetic resin or the like. A shutter plate 3 for opening or closing an aperture 2a, for partially exposing a signal recording area W of the disc 1 is slidably mounted on the cartridge 2. The shutter plate 3 is formed in an L-shape by bending a metal plate or by a resin plate or injection moulding of a synthetic resin material. The proximal end of a shorter side of the shutter plate 3 is bent to conform to the contour of the end face of the cartridge 2. The shutter plate 3 is supported at this bent portion by the cartridge 2.

As shown in Figure 3, the shutter plate 3 is displaced in a direction A for opening the aperture 2a. In other words, with the shutter plate 2a thus moved in the direction A, the optical head and the disc 1 are brought to a position facing each other. It is noted that, with the present reproduce-only disc, one of the major sides of the cartridge 2 is not provided with an aperture but is provided with a rectangular area 4 of a slightly lesser size than the outer contour of the cartridge 2 for application of a label etc for a picture or a legend indicating record contents of the disc 1.

Within the cartridge 2, there are provided a locking member 5 for locking the shutter plate 3 at a position closing the aperture 2a, and a shutter reset spring

6 for normally biasing the shutter plate 3 in the direction closing the aperture 2a.

When the cartridge 2 is introduced into a recording/reproducing apparatus via a cartridge inserting opening in the direction X, the locking state of the shutter plate 3 by the locking member 5 is released by a shutter opening member provided in the recording/reproducing apparatus. The shutter plate 3 is then slid against the bias of the spring 6 to open the aperture 2a. When the cartridge 2 is ejected from the recording/reproducing apparatus, the shutter plate 2 is slid by the spring 6 in the direction to close the aperture 2a.

An aperture 7 for entry of a disc table of a disc driving unit for rotationally driving the disc 1 is provided at a mid portion of the lower half on the bottom side of the cartridge 2. There are also provided positioning holes 8 and 9 on the lower half of the cartridge 2 into which positioning pins engage for positioning the cartridge 2 loaded onto a recording and/or reproducing section in the recording and/or reproducing apparatus.

A cartridge 12 having accommodated therein a magneto-optical disc 1 enabling overwriting of information signals is desired as shown in Figures 4 and 5. The cartridge 12 comprises an upper half and a lower half of synthetic resin similar to the above described cartridge 2. The cartridge 12 is provided with apertures 12a and 12b on its upper and lower sides, respectively, for radially exposing a portion of the signal recording area W of the disc 1. By the apertures 12a and 12b, the signal recording area W of the disc 1 is exposed to an optical head and to a magnetic head, respectively. Thus, when a shutter plate 13 is slid in the direction of the arrow A in Figure 5 to open the apertures 12a and 12b, the sides of the disc 1 are exposed.

The shutter plate 13 is of a U-shaped cross-section, unlike the above described shutter 3, and is formed by bending a metal or by a resin plate or by moulding a synthetic resin, and is mounted slidably on the front side of the cartridge 12.

The cartridges 2 and 12 are both of the same size with a transverse length a equal to 72 mm, a longitudinal length b equal to 68 mm and a thickness equal to 5 mm, as shown in Figures 2 and 4.

The lower half on the bottom of the cartridge 2 or 12 is provided with holes or projections 10a and 10b for discriminating whether the disc 1 accommodated therein is a reproduce-only disc or an overwrite type disc, as shown in Figures 3 and 5. The bottom of the cartridge 12 is also provided with a hole 10E as mistaken erasure inhibiting means, which may be a slidable pawl such as is used in a floppy disc, or a rupturable tongue such as is used in a compact cassette.

An apparatus for recording or reproducing audio signals on or from the disc 1 will now be described.

Figure 6 shows an embodiment of recording and/or reproducing apparatus which has been exceedingly simplified in structure through utilization of IC technology.

In the first place, recording on a magneto-optical disc will be explained. It is noted that the circuits of the apparatus are switched between the recording mode and the playback mode by a mode switching signal R/P from a system controller 20. A key operating section 38 is connected to the system controller 20 and a particular operating mode is designated by an input operation at the key operating section 38. The holes 10a and 10b are used to discriminate whether the disc is or is not a magneto-optical disc, and a discriminating output is supplied to the system controller 20.

2-channel analogue audio signals from an input terminal 21 are sampled to an A/D converter 22 at a sampling frequency of 44.1 kHz, and each sampled value is converted into a 16-bit digital signal. This 16-bit digital signal is supplied to a data compression/expansion circuit 23 operating as a data compression circuit during recording. In the present embodiment, input digital data are compressed to 1/4. There are a variety of data compression methods and, for example, an adaptive delta pulse code modulation (ADPCM) with a quantization bit number of four, for example, may be employed. As another method, the input digital data are divided into a plurality of bands so that the band width becomes broader towards a higher frequency range, a block composed of a plurality of samples is formed for each of the bands, with preferably the same number of samples from band to band, an orthogonal transform is performed for each band to obtain coefficient data, and bit allocation from block to block is performed on the basis of the coefficient data. High efficiency data compression may be achieved with this method since it takes into account of characteristics of the human auditory sense with respect to the sound.

In this manner, digital data DA from the A/D converter 22, shown at A in Figure 7, are compressed to 1/4 at the compression/expansion circuit 23, and compressed data da, shown at B in Figure 7, are transferred to a buffer memory 25 controlled by a track jump memory controller 24. In the present embodiment, a D-RAM having a capacity of 1 M bits is used as the buffer memory 25.

In the absence of a track jump, that is skipping of a recording position on the disc 1 due to vibration or the like during recording, the memory controller 24 reads out the compressed data from the buffer memory 25 at a transfer rate equal to 4 times the writing rate to transfer the read-out data to a data encode-decode circuit 26.

If a track jump is detected during recording, the memory controller 24 caused data transfer to the encode/decode circuit 26 to be terminated, while causing the compressed data da from the compres-

sion/expansion circuit 23 to be stored in the buffer memory 25. After the recording position has been corrected, the memory controller 24 causes data transfer to be re-initiated from the buffer memory 25 to the encode/decode circuit 26.

For detecting if a track jump has occurred, a vibration meter, for example, may be mounted on the apparatus to check if the magnitude of a vibration is such as will produce a track jump. It is noted that, with the disc 1, the absolute time code is recorded in superimposition on the wobbling signals for tracking control at the time of pregroove formation, as explained above. This absolute time code may be read from the pregroove during recording for detecting a track jump from the decoded output. Alternatively, an OR of the output of the vibration meter and the absolute time code may be then for detecting the track jump. It is noted that the laser light power is lowered or reduced to zero on occurrence of a track jump.

Correction of the recording position on occurrence of a track jump may be performed by using the above mentioned absolute time code.

It will be seem from above that the storage capacity corresponding to the compressed data corresponding to the time which elapses between the occurrence of a track jump and the correction of the recording position is required as a minimum storage capacity of the buffer memory 25. It will be recalled that, in the present embodiment, the buffer memory 25 has a memory capacity of 1 bits, which memory capacity has been selected as sufficient to satisfy the above requirement.

In this case, the memory control to be performed by the memory controller 24 is such that as small a data amount as possible be stored in the buffer memory 25 during the normal recording operation. More specifically, the memory control is such that, when the data amount in the buffer memory 25 exceeds a predetermined data volume, a preset data volume is read out from the buffer memory 25 so that a writing space in excess of a prescribed data volume is maintained in the buffer memory 25,

The encoding/decoding circuit 26 functions as an encoding circuit during recording for encoding the compressed data da transferred from the buffer memory 25 into data of a CD-ROM sector structure (about 2 Kybtes).

Output data from the encoding/decoding circuit 26 are supplied to a recording encoding circuit 26 in which the output data are processed with encoding for error detection and correction, herein cross interleave Reed Solomon code (CIRC) encoding, as well as modulation suited for recording, herein 8-to-14 modulation (EFM).

Encoded output data from the encoding circuit 27 are supplied via a magmetic head driving circuit 28 to a magnetic head 29. The driving circuit 28 actuates the magnetic head 29 so that a modulating magnetic field consistent with record data is applied to the disc 1 (magneto-optical disc). The record data on the disc 1 are as shown at D in Figure 6.

Although the disc 1 is accommodated in the cartridge 12, the shutter plate 13 is opened on loading the cartridge 12 into the recording and/or reproducing apparatus, so that the disc 1 is partially exposed via the apertures 12 and 12b. A disc table provided at the distal end of a driving motor 30M enters the aperture 15 for rotationally driving the disc 1. The disc driving motor 30M is controlled by a servo control circuit 32 as later described so that the disc 1 is thereby driven rotationally at a linear velocity of 1.2 to 1. 4 m/s.

A magnetic plate, not shown, is provided at the middle of the disc 1, while a magnet, also not shown, is provided on the disc table fitted on the output shaft of the motor 30M, so that the disc 1 is clamped to the disc table by magnetic attraction between the magnet and the magnetic plate.

The magnetic head 29 faces the side of the disc 1 exposed via the aperture 12a. An optical head 30 is provided for facing the side of the disc 1 opposite to that faced by the magnetic head 29. The optical head 30 faces the magnetic head 29 with the disc 1 in-between, upon opening of the aperture 12b. The optical head 30 comprises a laser light source, such as a laser diode, optical components, such as a collimator lens, an objective lens, a polarization beam splitter or a cylindrical lens, and a photodetector. During recording, laser light of a constant laser power larger than that during reproduction is irradiated on the recording track. As a result of the light irradiation and the modulating magnetic field applied by the magnetic head 29, information signals or data are recorded on the disc 1 by inverting the direction of the magnetic domain of the optical magnetic recording film of the disc 1 in accordance with the external magnetic field applied to the disc 1 by the magmetic head 29.

The magnetic head 29 and the optical head 30 are interconnected by connecting means, not shown, so as to be transported in unison along the radius of the disc 1, by transport means, not shown.

During decoding, an output of the optical head 30 is supplied via an RF circuit 31 to an absolute time decoding circuit 34, whereby the absolute time code from the pregroove of the disc 1 is extracted and decoded. The decoded absolute time information is supplied to the encoding circuit 27 whereby absolute time information is introduced into record data so as to be recorded on the disc 1. The absolute time information from the absolute time decoding circuit 34 is also supplied to the system controller 20 so as to be used for recognition of the recording position and position control, as mentioned previously.

With the above apparatus, it is possible to reproduce two types of discs, that is a reproduce-only optical disc and an overwrite the magneto-optical disc. These two types may be discriminated by detecting

the discrimination holes 10a and 10b. The two disc types may also be discriminated from the volume of the received light based on the different light reflection coefficients between the reproduce-only disc and the overwrite type disc. The disc discrimination output is supplied to the system controller 20 in a manner not shown.

The disc loaded on the apparatus is rotationally driven by the motor 30M which is driven under control of the servo control circuit 32 so that the disc 1 is rotationally driven at a constant linear velocity of 1.2 to 1.4 m/s, in the same way as during recording.

The optical head 30 detects, during reproduction, the light irradiated on and reflected from a target track for detecting focusing errors by, for example, an astigmatic method, while detecting tracking errors by, for example, a push-pull method. If the disc 1 is a reproduce-only optical disc, the optical head 30 detects reproduced signals by light diffraction at the pit train of a target track, whereas if the disc 1 is an overwritable magneto-optical disc, the optical head 30 detects the reproduced signals based on the detected difference in the angle of light polarization, that is a Kerr rotation angle, of the reflected light from the target track.

The output of the optical head 30 is supplied to the RF circuit 31 which extracts the focusing error signals and the tracking error signals from the output of the optical head 30 to transmit the extracted signals to the servo control circuit 32, while processing the playback signals into corresponding binary signals, which are transmitted to a playback encoding circuit 33.

The servo control circuit 32 performs focusing control of the optical system of the optical head so that the focusing error signal will be reduced to zero, while performing tracking control of the optical system of the optical head 30 so that the tracking error signal will be reduced to zero.

The RF circuit 31 extracts the absolute time code from the pregroove to transmit the extracted signal to the absolute time decoding circuit 34. The absolute time information therefrom is supplied to the system controller 20 to be used for controlling the playback position as the occasion may demand. The system controller 20 may also use sector-by-sector address information extracted from the playback area for supervising the position on the recording track scanned by the optical head 30.

A playback decoding circuit 33 receives the binary playback signals from the RF circuit 31 to perform an operation which is complementary to the operation performed by the recording encoding circuit 27, that is decoding for error detection and correction or 8-to-14 demodulation. Output data from the playback decoding circuit 33 are supplied to the encoding/decoding circuit 26.

The encoding/decoding circuit 26 functions as a decoding circuit during reproduction for decoding the CD-ROM sector format data into the original compressed data, and output data are transferred to the buffer memory 25 controlled by the track jump memory controller 24 so as to be written therein at a predetermined write rate.

If a track jump or skipping of the playback position due to vibration or the like should occur during reproduction, the memory controller 24 reads out the compressed data from the data encoding/decoding circuit 26 sequentially at a transfer rate equal to 1/4 the write rate to transfer the read out data to the data compression/expansion circuit 23.

On detection of a track jump during reproduction, the memory controller 24 terminates data writing from the encoding/decoding circuit 26 to the buffer memory 25, and only performs an operation of transferring data to the data compression/expansion circuit 23. When the playback position has been corrected, the memory controller 24 restarts data writing from the encoding/decoding circuit 26 to the buffer memory 25.

Detection of whether a track jump has occurred may be achieved in the same way as during recording, that is, by using a vibration meter, by using the absolute time code recorded in the pregroove of the disc 1 in superimposition on the wobbling signals for tracking control, that is by using a decoded output of the absolute time decoding circuit 34, or by taking an OR of the output of the vibration meter and the absolute time code. Alternatively, the absolute time information and the sector-by-sector address information, extracted from the playback data during reproduction as mentioned previously, may also be used for track jump detection.

Track position control, such as playback position correction, on occurrence of the track jump, may also be achieved by using the above mentioned address information, in addition to using the absolute time code, as mentioned previously.

It will be seen from above that the buffer memory 25 is of such a minimum capacity for reproduction that data corresponding to the time which elapses between occurrence of a track jump until correction of the playback position can be stored therein at all times, so it is possible to continue data transfer from the buffer memory 25 to the data compression/expansion circuit 23 despite the occurrence of a track jump. The memory capacity of 1 bits of the buffer memory 25 of the present embodiment is selected as being a capacity having a sufficient allowance to satisfy the above requirement.

It is to be noted that the optical disc according to the present invention is not limited to a reproduce-only optical disc or an overwritable optical disc, but may also be a write-once optical disc.

The overwritable optical disc may also be a phase-transition type optical disc taking advantage of crystal to amorphous phase transitions.

As the information recorded on the disc, video

signals, pattern signals such as characters (letter or figure) signals, code conversion signals or map information, may also be recorded, in addition or as an alternative to the audio signals.

Claims

1. A disc-shaped recording medium (1) comprising a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Bytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity.

2. A medium (1) according to claim 1 wherein absolute time information is recorded on said medium (1) in addition to the data compressed information.

3. A recording apparatus for a disc-shaped recording medium (1), the apparatus comprising a rotational driving means (30M) for rotationally driving the medium (1) which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Bytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising:

data compression means (23) for data-compressing input digital information;

recording encoding means (26, 27) for processing compressed data from said data compression means (23) by error correction encoding and predetermined modulation;

recording means (28) for recording encoded data from said recording encoding means on said medium (1); and

a buffer memory (25) associated with said data compression means (23) and said recording encoding means (26, 27), said buffer memory (25) having at least a data capacity capable of storing data from said data compression means (23) corresponding to a recording time between an occurrence of a track jump and resetting to a correct track position.

4. Apparatus according to claim 3 wherein said recording means (29) comprises vibration detecting means for detecting whether a track jump has occurred during a recording operation and controlling means (20) for terminating supply of the compressed data from said data compression means (23) to said recording encoding means (26, 27) and for supplying the compressed data from said data compression means (23) to said buffer memory (25) when a detection output from said vibration detecting means indicates occurrence of a track jump during the recording operation.

5. Apparatus according to claim 4 wherein said buffer memory (25) is controlled by said controlling means (20) so that data stored in said buffer memory (25) are read out at a rate which is consistent with the data compression rate of said data compression means (23) and which is higher than the data writing rate by said data compression means (23) into said buffer memory (25).

6. A reproducing apparatus for a disc-shaped recording medium (1), the apparatus comprising rotational driving means (30M) for rotationally driving the medium (1) which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Bytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising:

an optical head (30) for reading compressed data from said medium (1);

an RF circuit (31) for detecting playback signals from an output of said optical head (30);

playback decoding means (33) for processing said playback signals from said RF circuit (31) by error correction decoding and by demodulation complementary to modulation performed during recording;

data expansion means (23) for expanding compressed data from said playback decoding means (33); and

a buffer memory (25) associated with said playback decodine means (33) and said data expansion means (23), said buffer memory (25) having a capacity at least sufficient to supply data to said data expansion means (23) corresponding

to a playback time between occurrence of a track jump and resetting of said playback position to a correct track position.

7. Apparatus according to claim 6 comprising vibration detecting means for detecting whether a track jump has occurred during a reproducing operation, and controlling means (26) for terminating the writing of the data from said playback decoding means (33) to said buffer memory (25) and for only transferring data to said expansion means (23) when a detection output from said vibration detecting means indicates an occurrence of a track jump during reproduction.

8. A recording and/or reproducing apparatus for a disc-shaped recording medium (1), the apparatus comprising rotational driving means (30M) for rotationally driving the medium (1) which comprises a disc-shaped transparent base plate, a recording film provided on said base plate and a protective film provided on said recording film, wherein said base plate has a diameter not larger than 80 mm, a recording track is formed at a track pitch of approximately 1.6 μm, and not less than 130 Mbytes of information is recorded on said recording track in a data compressed state, and wherein recording of information signals and/or reproduction of recorded information signals is effected at a constant linear velocity, the apparatus further comprising:

data compression means (23) for data-compressing input digital information;

recording encoding means (26, 27) for processing compressed data from said data compression means (23) by error correction encoding and predetermined modulation;

recording means (29) for recording encoded data from said recording encoding means (26, 27) on said medium (1);

an optical head (30) and means (29) for generating an external magnetic field provided facing each other with said medium (1) in-between;

an RF circuit (31) for detecting playback signals from an output of said optical head (30);

playback decoding means (26, 27) for processing said playback signals from said RF circuit (31) by error correction decoding and by demodulation complementary to modulation performed during recording;

data expansion means (23) for expanding the compressed data from said playback decoding means (26, 27); and

a buffer memory (25) associated with said playback decoding means (33, 26) and said data expansion means (23), said buffer memory (25) having a capacity at least sufficient to supply data to said data expansion means (23) corresponding to a playback time between the occurrence of a track jump and resetting of said playback position to a correct track position.

9. Apparatus according to claim 8 further comprising vibration detecting means for detecting whether a track jump has occurred during a recording operation or a reproducing operation, and controlling means (20) for terminating supply of the compressed data from said data compression means (23) to said recording encoding means (26, 27) and supplying the compressed data from said data compression means (23) to said buffer memory (25) when a detection output from said vibration detecting means indicates an occurrence of a track jump during a recording operation of recording information signals on said medium (1) by said optical head (30) and said means (29) for generating an external magnetic field, and for controlling the operation of said buffer memory (25) for terminating the writing of data from said playback decoding means (33, 26) to said buffer memory (25) and only transferring data to said expansion means (23) when the detection output from said vibration detecting means indicates an occurrence of a track jump during a reproducing operation by said optical head (30).

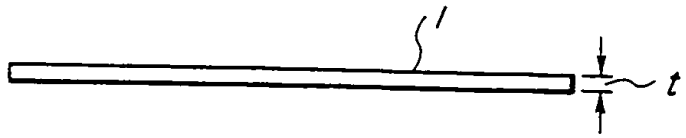

FIG.1B

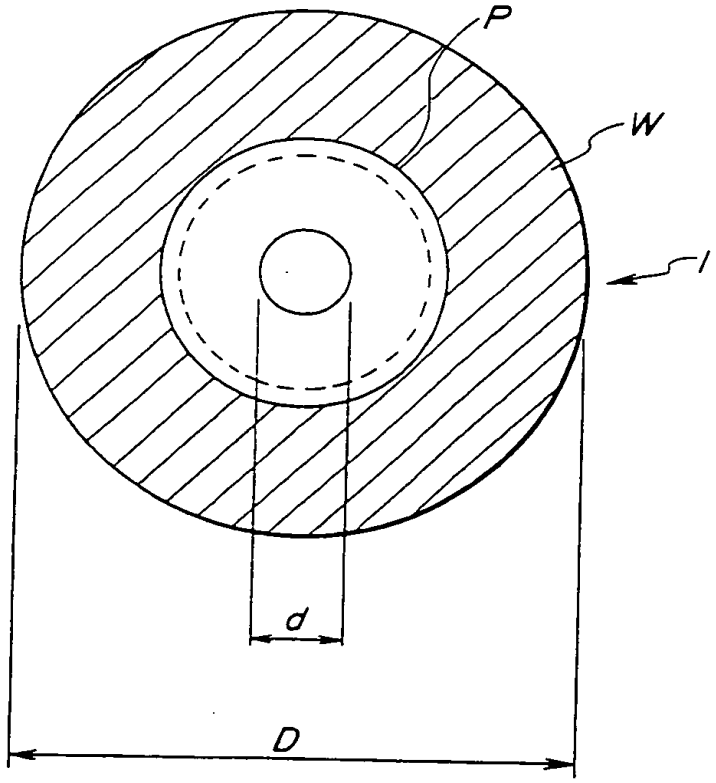

FIG.1A

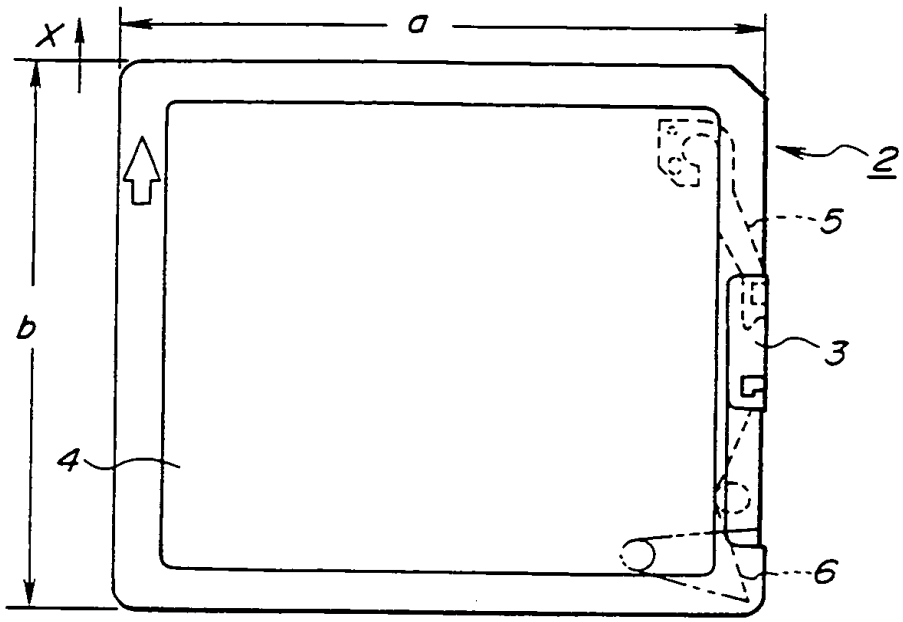

FIG. 2

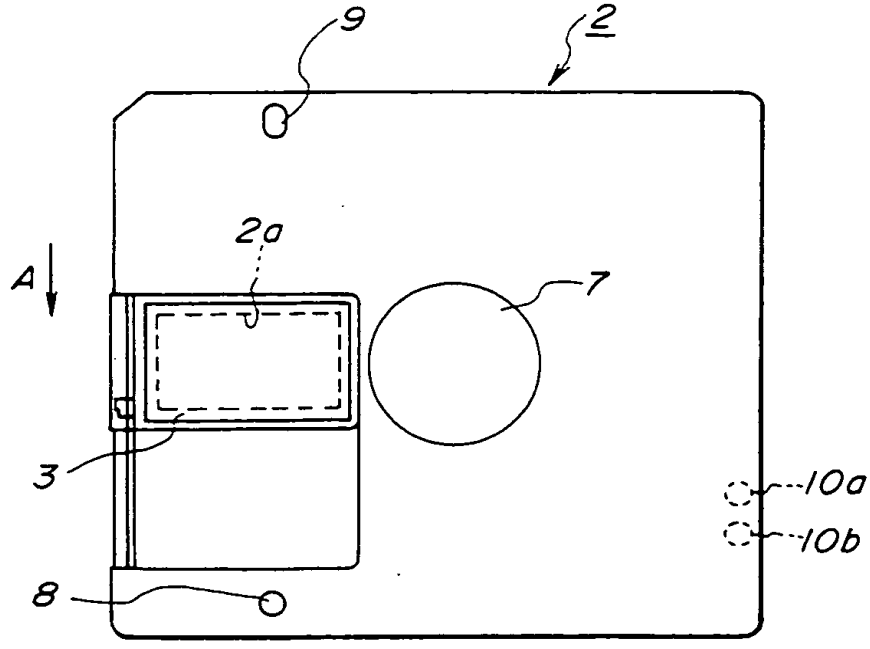

FIG. 3

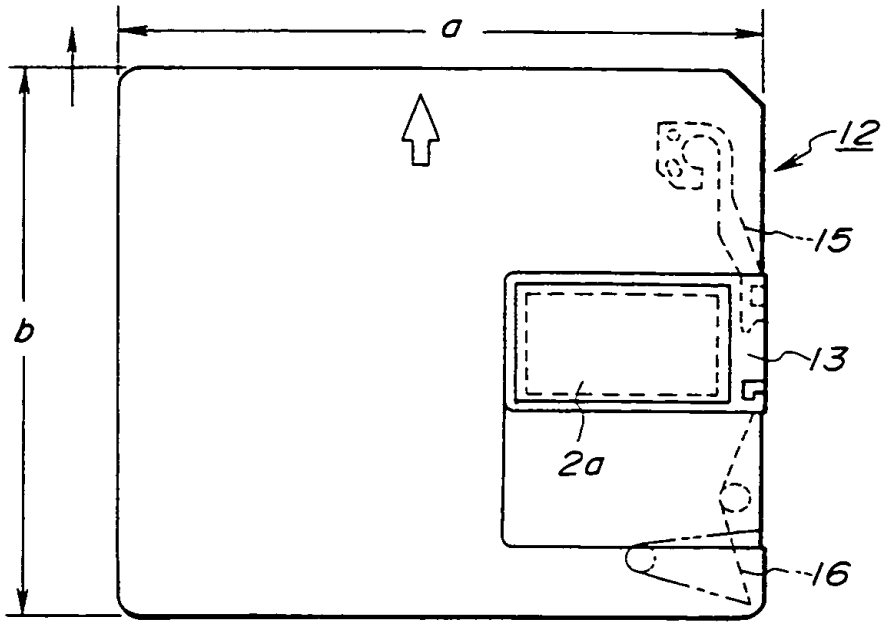

FIG. 4

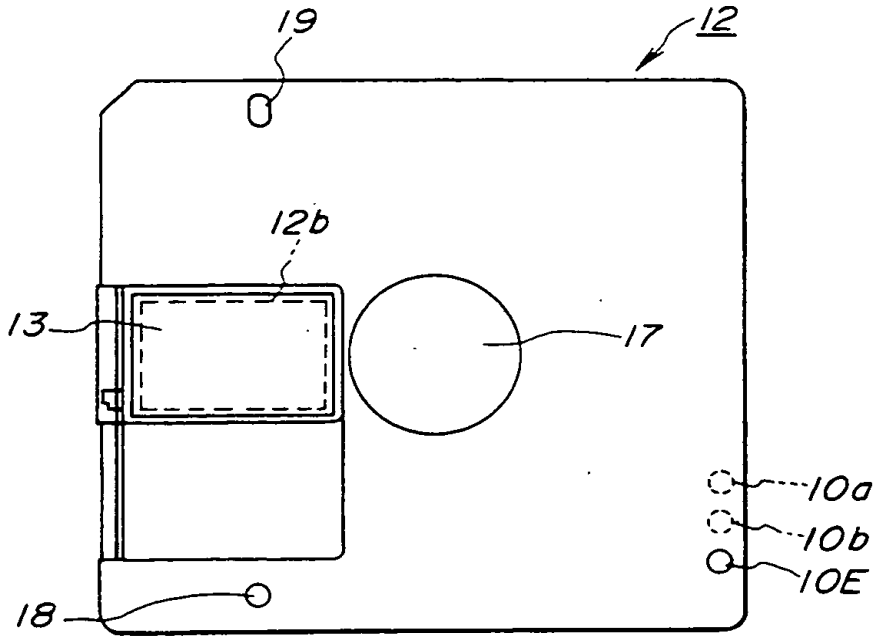

FIG. 5

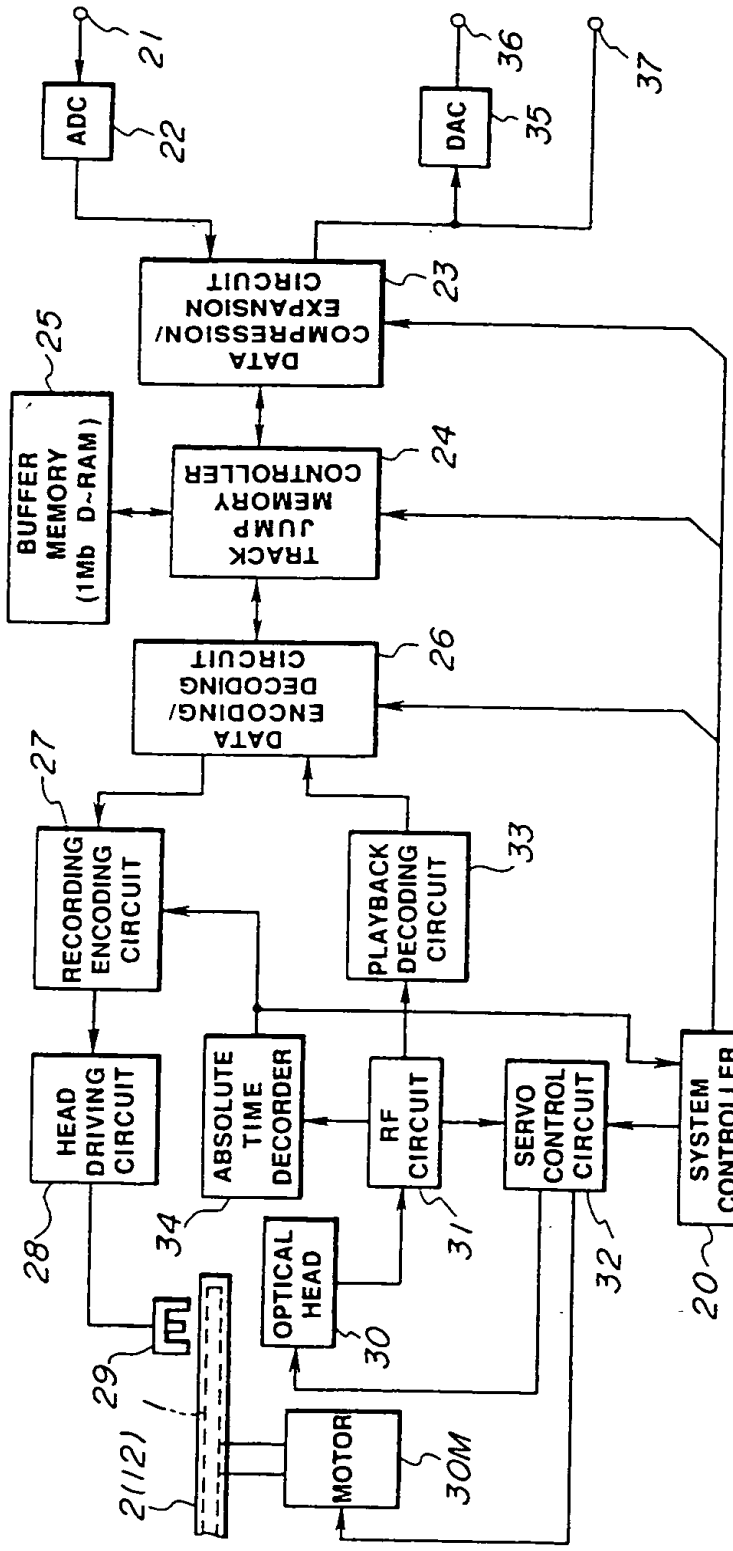
ADC
22
21
DAC
35
36
37
DATA COMPRESSION/ EXPANSION CIRCUIT
23
25
BUFFER MEMORY (1Mb D-RAM)
TRACK JUMP MEMORY CONTROLLER
24
DATA ENCODING/ DECODING CIRCUIT
26
27
RECORDING ENCODING CIRCUIT
PLAYBACK DECODING CIRCUIT
33
HEAD DRIVING CIRCUIT
28
ABSOLUTE TIME DECORDER
34
RF CIRCUIT
31
SERVO CONTROL CIRCUIT
32
SYSTEM CONTROLLER
20
KEY INPUT OPERATING SECTION
38
OPTICAL HEAD
30
29
2(12)
1
MOTOR
30M

FIG.6

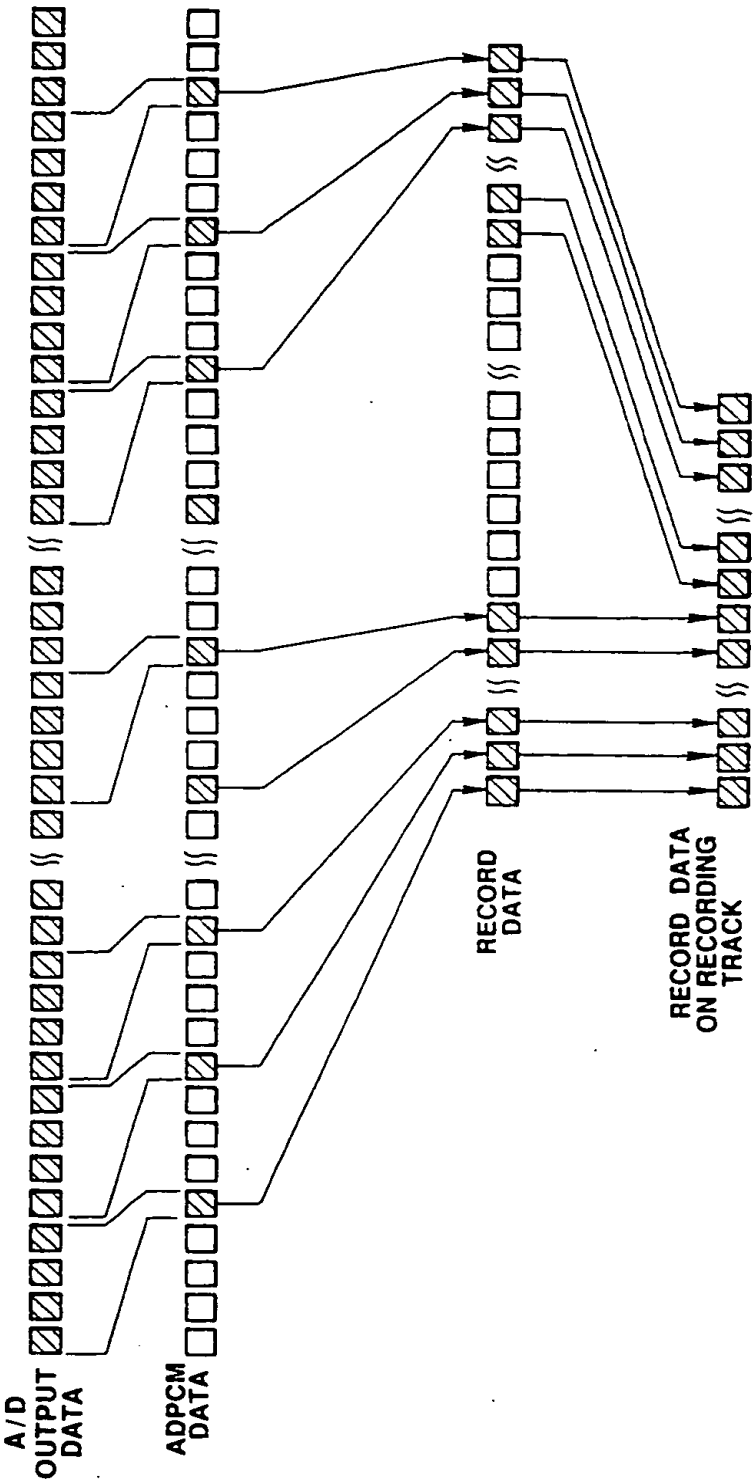
A/D OUTPUT DATA
ADPCM DATA
RECORD DATA
RECORD DATA ON RECORDING TRACK

FIG.7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number EP 91307287.2

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP - A2 - 0 326 437 (SHARP K.K.) * Fig. 3; claims 1-5 * --	1,3-9	G 11 B 7/00 G 11 B 21/10
Y	EP - A2 - 0 260 722 (TOSHIBA K.K.) * Fig. 10; abstract * --	1,3-9	
A	US - A - 4 805 046 (KUROKI et al.) * Fig. 2; abstract * ----	1-9	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 11 B 7/00
G 11 B 21/00
G 11 B 5/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	07-11-1991	BERGER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

& : member of the same patent family, corresponding document

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